• **School of Engineering Science**
• **Simon Fraser University**
• **Burnaby BC, V5A 1S6**
• **asa128@sfu.ca**

January 18, 2014

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re**:** ENSC Project Proposal for Air Surveillance Drones

Dear Dr. Rawicz,

Our company Air Surveillance Drones is proposing the built of an autonomous radio controlled aircraft with applications for search and rescue, law enforcement, forest fire watch among others. The objective is to make the drone as economical as possible in order to extend its affordability to a wider range of applications.

Attached is our proposal with an overview of required materials, design considerations, projected budget and a tentative timeline for completion and an introduction of our company.

Our company was created by three dedicated engineering science students: Armin Samadanian, Juan Carlos Diaz and Afshin Nikzat. We thank you for considering our proposal and look forward to hearing from you. If you have any further questions please do not hesitate to contact us at asa128@sfu.ca

Sincerely,

Armin Samadanian
CEO
Air Surveillance Drones

Air Surveillance Drone
Proposal

Company: Armin Samadanian
Afshin Nikzat
Juan Carlos Diaz

Executive Summary

Applications such as search and rescue or forest fire watch often require aerial surveillance in order to be properly executed. At present times air surveillance requires expensive machines such as full-scale helicopters as well as a large amount of manpower. The creation of an economical and simple to use radio controlled aircraft would be a viable and inexpensive solution for these as well as to many other applications.

Air Surveillance Drones (ASD) is passionate about creating low-maintenance inexpensive aircraft systems with a minimum range of 10 kilometers that can efficiently handle weather as well as difficult terrain thanks to its integrated GPS module.

The ability to operate the aircraft will be provided by a custom-built ground station that will include several antennas and video equipment. A single person using an FM RC transmitter with increased range will operate the aircraft reducing the amount of manpower required for several applications such as search and rescue.

The use of an FPV (First Person View) system together with a night vision camera mounted on a three-axis actuated gimbal would allow the aircraft to provide the ground station control with a detailed 360-degree view of the area in real time. This function will also serve as the main visual navigation in conjunction with a telemetry module that can display battery charge, airspeed and altitude.

For our project to be a viable solution, it needs to be cost effective to increase its application range. The combined cost of all the systems and the aircraft itself will be below $1650.00.

Table of Contents

List of Figures and Tables

1 Introduction

Every year there many people get lost in forests and mountains. The most efficient way to search for them is to use helicopters; however it is very costly. Moreover helicopter search usually ends by sunset making it almost impossible to continue the overall search at night. This problem can be solved by using a drone equipped with night vision that can fly for a long range and extended periods of time. Currently the funding for BC Search and Rescue Association is about $8.2 million [(1)]. Another application of this drone is locating forest fires. The ten-year average of forest fire incidents from 2002 to 2012 is 1,922 fires [(2)]. These costs will be reduced greatly if the rescue/firefighter team is sent after locating the fire with a drone.

The Drone is very easy to operate and there wouldn't be need of more than one person to operate. The system will use a GPS module interfaced with a computer allowing the operator to find the exact coordinates of the drone in real-time. Thermal cameras might be installed besides the night vision camera depending on the total payload of the airplane after all the equipment is set up primarily for SAR operations.

Generally there are two major difficulties with using a drone, range and flight time. To solve the problem of range there will be a ground station equipped with helical custom built antennas to amplify and boost the signal for a longer range. In order to increase flight time during sunny days, a solar cell module will be installed on the aircraft. The solar recharge system will be easily detachable to make the plane lighter for night search.

There are many other applications to the drone:

- Night search rescue missions
- Forest Fire watch
- Law enforcement
- Marine search
- Aerial filming
- Aerial surveillance
- Property Filming
- Animal Search and Rescue

2 Project Overview

2.1 Weight and Aerodynamic Considerations

The aircraft's ability to fly for extended periods of time will be limited by the total weight of the aircraft as well as air-drag, therefore the aircraft as well as the systems that comprise it need to be as light as possible as well as aerodynamically efficient.

2.2 Power System

The power system will consist of a 550kv brushless out-runner motor that produces around 2.5kg of thrust when equipped with a 15x8 propeller and two 4-cell lithium polymer batteries [4]. This system will be adequate due to its low power consumption and large power output in high-load conditions as well as its low cost.

2.3 Radio System

The choice of a radio system needs to be comprised of a 9-channel transmitter and a 9-channel receiver. Two technologies are available, FM and 2.4Ghz variable band. We have chosen FM due to its increased range together with an autopilot system that returns the aircraft within safe range in case there was interference.

2.4 FPV System

The FPV system we have chosen is comprised of several modules in order to increase the regular 2km range of normal FPV systems. Our design incorporates the use of a 5.8ghz 2-way video system and a custom built unidirectional helical antenna that will allow video transmission up to 10kms. The camera chosen for such system incorporates low-light technology that will make night missions possible and effective.

2.5 Autopilot System

An autopilot system will also be incorporated into the aircraft. This system will allow mission programming capabilities through GPS and Google maps making it possible to automate the drone for the majority of the mission while allowing manual control of the gimbal mounted camera for surveillance operations. Furthermore, in case the radio frequency controlling the aircraft encounters any noise or loses strength, the autopilot will automatically use the launch GPS coordinates and return the aircraft safely to the launch site.

3 Extended Features and Risk Reduction

3.1 Increased Range

Increasing the range of our aircraft would extend its usefulness in almost all applications. The incorporation of a solar-wind recharging system comprised of solar cells as well as wind powered electric generators that can also function as airbrakes would allow the aircraft to fly for a longer time therefore increasing its range for as long as the radio-video system permits.

3.2 Thermo-imaging Camera

For search and rescue operations, night vision helps scouting areas at night but its ability to find missing persons would be greatly increased by a thermo-imaging camera. These systems can be quite expensive and heavy

3.3 Risk Reduction Strategy

The risk of losing the aircraft during the testing phase will be reduced by the use of an "expendable" low cost aircraft in which the systems will be individually tested before incorporating them to the final hand-built airplane shown in Figure 1.

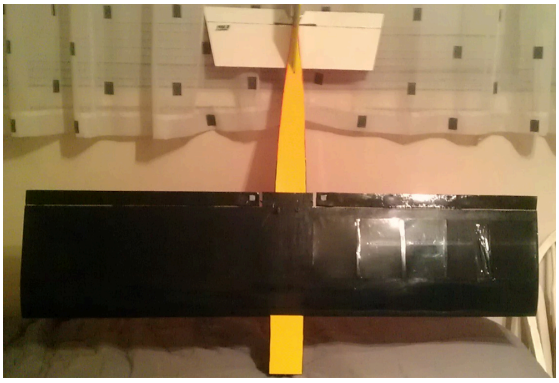

Figure 3.1 – Semi-built Handmade Aircraft

Figure 3.2- Aircraft Components

4 Cost Estimations and Funding

Table 1 shows the cost of the components required to build the Air Surveillance Drones (ADS).

Equipment List	Estimated Cost
Model Plane Building Materials	$350
1 x Boscam Video Receiver (RC 305 5.8 GHZ)	$50
1 x Boscam Video Transmitter (TS 353 5.8 GHZ 400mW)	$60
1 x Fat Shark FPV goggles	$200
1 x HD night vision FPV camera	$75
1 x 9CH FM Radio/Receiver	$275
2 x Batteries	$100
1 x Solar Cells	$130
1 x Engine (Turnigy G46 brushless outrunner 550kv)	$50
1 x Autopilot (F-TEK 31AP)	$140
1 x UBEK	$30
5 x Servos	$100
1 x Antennas	$40
1 x Cam mount (RC 5.8 GHZ FPV anti-vibration PTZ)	$50
Total Cost	$1650

Table 4.1- List of Parts and Cost

The cost for this project is estimated to be around $1650. The availability of funds is crucial for the completion of the project. The team has applied to the Engineering Science Student Society Endowment Fund (ESSSEF). The other sources of funding being considered are the Simon Fraser Student Society. Also since the potential market for ASD is huge, the team feels strongly about the success of this Project.

5 Tentative Schedule

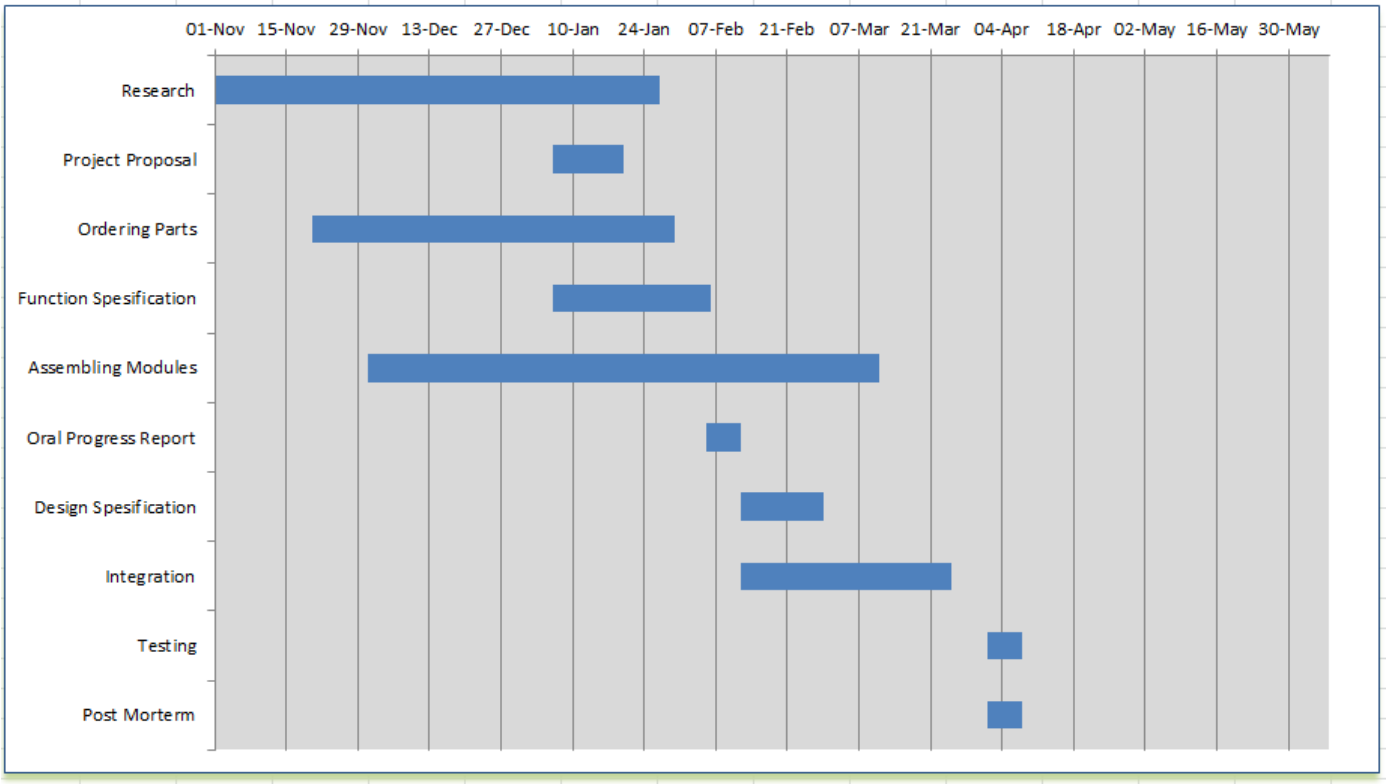

Figure 5.1- Gann Chart

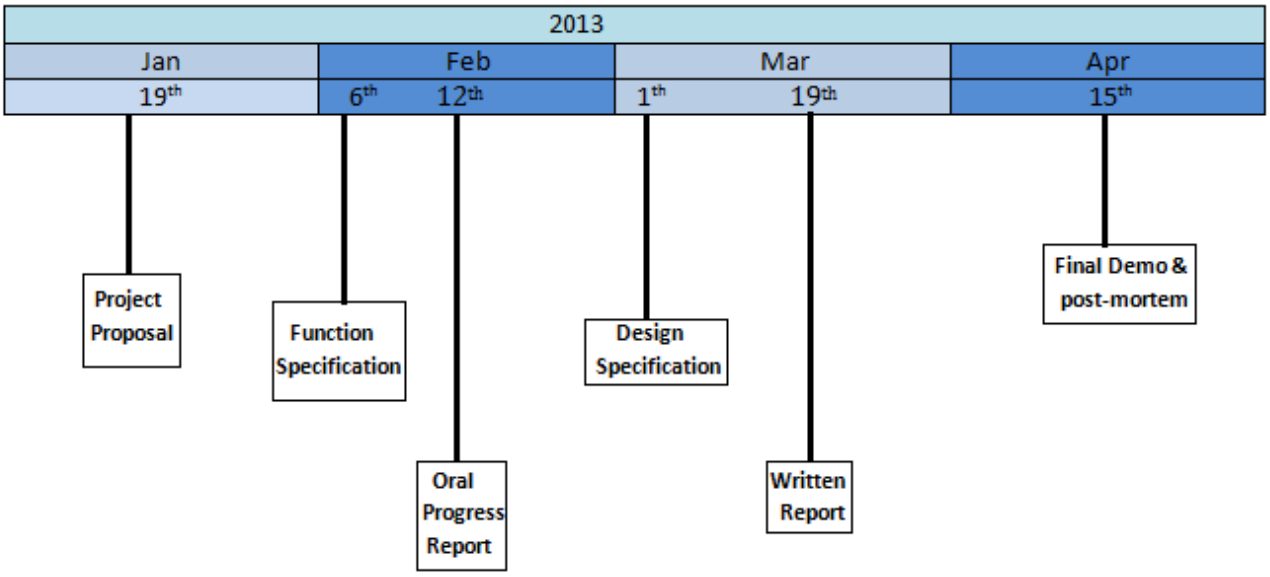

Figure 5.2- Milestone Diagram

6 Company Profile

Founded in 2014 by Armin Samadanian, Afshin Nikzat and Juan Carlos Diaz; Air Surveillance Drones is committed to producing quality cost-effective aerial surveillance solutions for diverse applications. ASD was brought to life when Juan Carlos Diaz added a camera to one of his RC helicopters and realized the huge potential RC aircraft could have if they could be flown from long distances while being able to transmit real-time video.

Due to his vast experience building hand made balsa wood aircraft, Afshin Nikzat is in charge of aircraft design and production as well as any aero dynamical considerations to increase flight time and reduce air-drag. He is also the financial planner thanks to his past work experience in the food industry.

Thanks to his experience building RC helicopters and programming of components, Juan Carlos Diaz will be handling research as well as system assembly and component debugging throughout the project. He is also the test pilot being he is the most experienced RC flyer of the team.

Armin Samadanian has a well-founded knowledge of RF and has hands-on experience in the laboratory where he has experimented building several types of antennas and amplifiers. Furthermore, Armin will be in charge of project management and team coordination.

7 Company Founders Profile

Armin Samadanian – Chief Executive Officer
Fourth year Electronics Engineering student with a good back ground in Communication Systems and radio frequency devices. He has extensive experience in both object-oriented design, such as C++, and hardware design, such as VHDL. He has good communication and Oral skills that will be an asset in his managerial position on this project.

Afshin Nikzat– Lead Financial Planner and Lead Builder
Fourth year Electronics Engineering student with a lot of experience working and operating model airplanes. He will be in charge of building, modifying, repairing and installing parts on the drone. Due to his experience in this field he is in charge of planning financially and buying parts.

Juan Carlos Diaz – Lead Technician and Test Pilot
Senior year Systems Engineering student with experience in Solidworks, AutoCad and Embedded Systems. Juan has excellent hands-on mechanical skills and has experience flying and building RC helicopter and airplane systems.

8 Conclusion

Air Surveillance Drones is aiming to minimize the cost of aerial surveillance in various situations. The drones built by ASD will also be capable of operating at night when other options are not available. There are many other situations that these drones are most efficient. They will be simple to operate while requiring only one person to maintain operation.

In the future we expect to be able to add several other applications to these drones. These applications will include different modules that are useful in a wide range of situations and will be easy to swap to get the best performance. At ASD, we hope to bring environmental friendly drones to effectively help in various situations that otherwise would be impossible or very costly to execute.

9 Glossary

R/C or RC:
The use of radio signals to remotely control a device is called Radio-Controlled (RC). It is achieved by means of a handheld Radio transmitter to control the vehicle.

FPV:
First Person View is a technique to control RC devices from distance. This method gives the capability of controlling vehicles from farther distances by using a camera. The camera will provide a first person perspective view for pilot as if he were onboard. This is also known as Remote Person View (RPV).

RF:
Radio Frequency is a rate of oscillation that relates to frequency of the wave. RF is mainly used for wireless communications.

FM:
Frequency Modulation is a method used to encode and transmit information using signals. Then the modulated signal will be demodulated at destination and data will be extracted.

GPS:
Global Positioning System is a system to obtain location and time information anywhere on earth using satellite navigation system.

SAR or S&R:
Search And Rescue is when a person is in need of immediate aid with no awareness of their location. There are a few sub fields, such as mountain, ground, urban, combat and air/sea search and rescue.

10 References

[1] The Vancouver Sun. (September, 2013)
Retrieved from
http://www.vancouversun.com/news/Search+Rescue+Association+Consider+user+fees+recreational+activities+make+funding+shortfall/8928057/story.html

[2] B.C. Wildfire Management Branch
Retrieved from
http://bcwildfire.ca/history/average.htm

[3] FPV Pilot
Retrieved from
http://www.fpvpilot.com/Pages/default.aspx

[4] RC Universe
Retrieved from
http://www.rcuniverse.com/forum/beginners-85/8682070-46-glow-electric-conversion.html